

<b>TECHNICAL AIRWORTHINESS AUTHORITY ADVISORY (TAA ADVISORY)</b>	
Title	<b>Airworthiness Clearance for Operations in Performance-Based Navigation (PBN) Airspace</b>
TAA Advisory Number	<b>2019-05e</b>
Effective Date	<b>21 MAY 2020</b>
Reference	<b>C-05-005-001/AG-002 – <i>Airworthiness Design Standards Manual, Part 3, Chapter 3</i></b>
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## **1. Purpose**

- 1.1 This Technical Airworthiness Authority (TAA) Advisory provides guidance on obtaining airworthiness approval and Technical Airworthiness Clearance (TAC), as well as an Operational Airworthiness Clearance (OAC) for Department of National Defense and the Canadian Armed Forces (DND/CAF) aircraft to operate in Performance-Based Navigation (PBN) Airspace.
- 1.2 Specifically, this document provides advisory material for:
- a. demonstrating compliance with the certification requirements that are applicable to PBN designs, as specified in Parts 2 and 3 of the Technical Airworthiness Manual (TAM) (regulatory reference 3.2.1.a);
  - b. demonstrating compliance with the PBN design and certification requirements specified in Part 3, Chapter 3 of the Airworthiness Design Standards Manual (ADSM) (regulatory reference 3.2.1.b);
  - c. defining the PBN means of compliance to be used in demonstrating compliance with the certification basis; and
  - d. obtaining a Technical Airworthiness Clearance (TAC) and Operational Airworthiness Clearance (OAC) for a PBN capability.
- 1.3 This advisory augments the airworthiness regulatory requirements for design certification, TAC and OAC that are published in the following regulatory references:
- a. Type Certification – TAM, Part 2, Chapter 1 (regulatory reference 3.2.1.a);
  - b. Design Change Certification – TAM, Part 3, Chapter 2 (regulatory reference 3.2.1.a);
  - c. Technical Airworthiness Clearance – TAM, Part 2, Chapter 3 (regulatory reference 3.2.1.a);
  - d. Performance Based Navigation – ADSM, Part 3, Chapter 3 (regulatory reference 3.2.1.b); and
  - e. Operational Airworthiness Manual – OAM, Chapter 3, Section 312, (regulatory reference 3.2.1.c).

## **2. Applicability**

- 2.1 This advisory applies to all DND/CAF personnel, as well as their support contractors, who are seeking to obtain an airworthiness approval for a PBN capability on DND/CAF aircraft. This

advisory replaces TAA Advisory 2012-02 – Required Navigation Performance/Performance-Based Navigation [RESCINDED].

- 2.2 This advisory is applicable to aircraft installations that use Global Navigation Satellite System (GNSS), Distance Measuring Equipment (DME), Very High Frequency (VHF) Omni-Directional Range (VOR) or inertial reference systems (IRS) in PBN operations.
- 2.3 This advisory is not applicable to the certification of precision approach systems, such as Instrument Landing Systems (ILS) or GNSS Landing Systems (GLS), nor is it applicable to standalone VHF Omni-Range (VOR) and Automatic Direction Finder (ADF) installations.
- 2.4 This guidance may be adapted for use in performing the Type Design Examination (TDE) of a PBN capability that has been previously approved by a TAA-recognized airworthiness authority.
- 2.5 Throughout this document, the term ‘Applicant’ is used to refer to the organization applying for a PBN design approval. For a new DND/CAF aircraft fleet, this is normally the Systems Engineering Manager (SEM) in a Project Management Office (PMO). For design changes to existing DND/CAF aircraft, the applicant is the Weapon System Management (WSM) organization.
- 2.6 The standard Operational Airworthiness Clearance (OAC) requirements are defined in the Operational Airworthiness Manual (OAM) (regulatory reference 3.2.1.c). Annex J to this advisory identifies the specific PBN requirements associated with issuing an OAC.

### 3. Related Material

- 3.1 **Definitions.** The terminology used in this document are from either the Glossary of the Technical Airworthiness Manual (TAM) (regulatory reference 3.2.1.a) or the Airworthiness Design Standards Manual (ADSM), Part 3, Chapter 3 (regulatory reference 3.2.1.b).

### 3.2 References

#### 3.2.1 Regulatory References

- a. C-05-005-001/AG-001 – *Technical Airworthiness Manual (TAM)*;
- b. C-05-005-001/AG-002 – *Airworthiness Design Standards Manual (ADSM)* – Part 3, Chapter 3 – Aircraft Navigation Systems; and
- c. [B-GA-104-000/FP-001 – Operational Airworthiness Manual \(OAM\)](#).

#### 3.2.2 Non-Regulatory References

- a. [Federal Aviation Administration \(FAA\) Advisory Circular \(AC\) 20-138D](#) – Change 2 (or later revision) – *Airworthiness Approval of Positioning and Navigation Systems* (also available internally, within DND, at AEPM RDIMS #1932981);
- b. [ICAO Navigation Specifications](#) – Navigation Specifications are published in the ICAO PBN Manual, Volume II, Parts B (RNAV) and Part C (RNP);
- c. [ICAO PBN Manual, Performance Based Navigation \(PBN\) Manual](#) – Fourth Edition – 2013, Doc 9613-AN/937 (available internally, within DND, at AEPM RDIMS #1847267);
- d. RTCA DO-200B – *Standards for Processing Aeronautical Data*;
- e. RTCA DO-283B – *Minimum Operational Performance Standards for Required Navigation Performance for Area Navigation*;
- f. RTCA DO-236C with Change 1 – *Minimum Aviation Systems Performance Standards: Required Navigation Performance for Area Navigation*;

- g. RTCA DO-229D – *Minimum Operational Performance Standards for Global Positioning System/Wide Area Augmentation System (GPS/WAAS) Airborne Equipment*;
- h. [FAA TSO-C115d](#) – *Required Navigation Performance (RNP) Equipment - Multi-Sensor Inputs*;
- i. [ICAO Doc 4444](#) – *PANS-ATM, Procedures for Aircraft Navigation Services – Air Traffic Management, 2016, 16th Edition*;
- j. EASA Safety Information Bulletin ([SIB](#)) 2014-04 – *RNP Approach with Baro-VNAV*;
- k. FAA AC 20-129 (Cancelled) - *Airworthiness Approval of Vertical Navigation (VNAV) Systems for use in the U.S. National Airspace System (NAS) and Alaska*;
- l. EASA Certification Memo ([CM](#)) AS-002 Issue: 02, dated 28 March 2014;
- m. [RCAF Flight Operations Manual](#) (21 Dec 2019);
- n. [FAA Advisory Circular \(AC\) 20-153](#) – *Acceptance of Aeronautical Data Processes and Associated Databases*; and
- o. RTCA DO-229 – *Minimum Operational Performance Standards for Global Positioning System/Wide Area Augmentation Systems Airborne Equipment*.

#### NOTE

*As a matter of courtesy, the staff of the Director – Technical Airworthiness and Engineering Support 6 may provide copies of up-to-date versions of the RTCA publications referenced above. To obtain a copy, contact the Team Leader – Avionics Systems Engineering – Navigation and Flight Deck, DTAES 6-4.*

### 3.3 Airworthiness Requirements

- 3.3.1 Adding a PBN capability to a DND/CAF aircraft is a major design change that requires a Technical Airworthiness Clearance (TAC) and Operational Airworthiness Clearance (OAC) before the capability can be released for operational use.
- 3.3.2 **Technical Airworthiness Clearance.** A PBN design must meet the standard certification and TAC requirements defined in the TAM rules and standards (regulatory reference 3.2.1.a) for a new aircraft design, or an in-service design change. In addition, there are PBN specific requirements published in the ADSM (regulatory reference 3.2.1.a.).
- 3.3.3 **Operational Airworthiness Clearance.** The standard OAC requirements are defined in the Operational Airworthiness Manual (OAM) (regulatory reference 3.2.1.c). Annex J to this advisory identifies the specific PBN requirements associated with issuing an OAC.
- 3.3.4 **ICAO Navigation Specifications.** As described in the ADSM, paragraph 3.3.7.7 (regulatory reference 3.2.1.b), the TAA and OAA have adopted the ICAO Navigation Specifications as the primary DND requirements applicable to the certification and approval of PBN capabilities for DND/CAF aircraft. The Navigation Specifications are published in Volumes 2 of the ICAO PBN Manual (reference 3.2.2.c).
- 3.3.5 **FAA Advisory Circular (AC) 20-138D.** As described in the ADSM, paragraph 3.3.7.16 (regulatory reference 3.2.1.b), the TAA and OAA have adopted the FAA's Advisory Circular (AC) No. 20-138D (reference 3.2.2.a) as the TAA's preferred means of demonstrating compliance with the PBN design, certification and certification requirements that are published in the ICAO Navigation Specifications (reference 3.2.2.b). AC 20-138D embodies up-to-date guidance built on the FAA's extensive knowledge and experience. Throughout this document and its annexes, any reference to AC 20-138D will mean AC 20-138D Change 2, or subsequent version.

## 4. Discussion

### 4.1 Background

- 4.1.1 Performance-Based Navigation (PBN) is a core element of the wider air traffic management initiative called Communications, Navigation, Surveillance / Air Traffic Management (CNS/ATM). The CNS/ATM concept specifies that before aircraft are allowed access to PBN designated airspace, the aircraft navigation systems must have been certified as meeting the PBN performance requirements that are defined in terms of accuracy, integrity, continuity and functionality. PBN provides the means to achieve the operational capabilities required to enable global operations with and, in some cases, without constant Air Traffic Control (ATC) monitoring/surveillance.
- 4.1.2 The PBN concept requires that any aircraft authorized to fly in PBN airspace be certified by their national airworthiness authority (civilian or military), as meeting the applicable PBN navigation specification requirements. To avoid denial of access to PBN-designated airspace, DND/CAF aircraft must be equipped and certified to meet the performance requirements associated with the PBN-designated airspace in Canada and world-wide. Additional PBN system descriptive information is available in the ADSM, Part 3, Chapter 3, paragraph 3.3.7 (regulatory reference 3.2.1.b).
- 4.1.3 The certification of a PBN capability shall follow the normal design certification process defined in the TAM (regulatory reference 3.2.1.a), plus those additional PBN-specific requirements identified in the Part 3, Chapter 3 of the ADSM (regulatory reference 3.2.1.b), including:
- following the provisions of the DND/CAF Airworthiness Program policy for Communications, Navigation, Surveillance / Air Traffic Management (CNS/ATM) and its application for PBN;
  - applying FAA Advisory Circular 20-138D – *Airworthiness Approval of Positioning and Navigation Systems* during the certification program, as the TAA-preferred means of demonstrating compliance for PBN; and
  - developing and obtaining approval of a PBN Capability Statement that will be inserted into the AFM/AOI.
- 4.1.4 In addition to the PBN design and certification requirements described in the ADSM, it is recommended that the following documents, described in the main body of this advisory (with additional guidance on development provided in its annexes), be developed to support the PBN design certification process:
- PBN Criteria Table;
  - PBN Design Assessment Report; and
  - Airworthiness Approval Substantiation Report.
- 4.1.5 The primary elements of the airworthiness approval process for a PBN design are illustrated in Figure 1.

### 4.2 Process Overview

- 4.2.1 As shown in Figure 1, the airworthiness approval process for a new PBN capability is based on the following steps:
- Step 1: Identifying the PBN Operational Requirements.** Using the PBN operational requirements provided by the Royal Canadian Air Force (RCAF) Air Staff, the applicant identifies the specific RNP and RNAV capabilities and functions that are required for a particular DND/CAF aircraft fleet. Annex A provides additional guidance on this step.

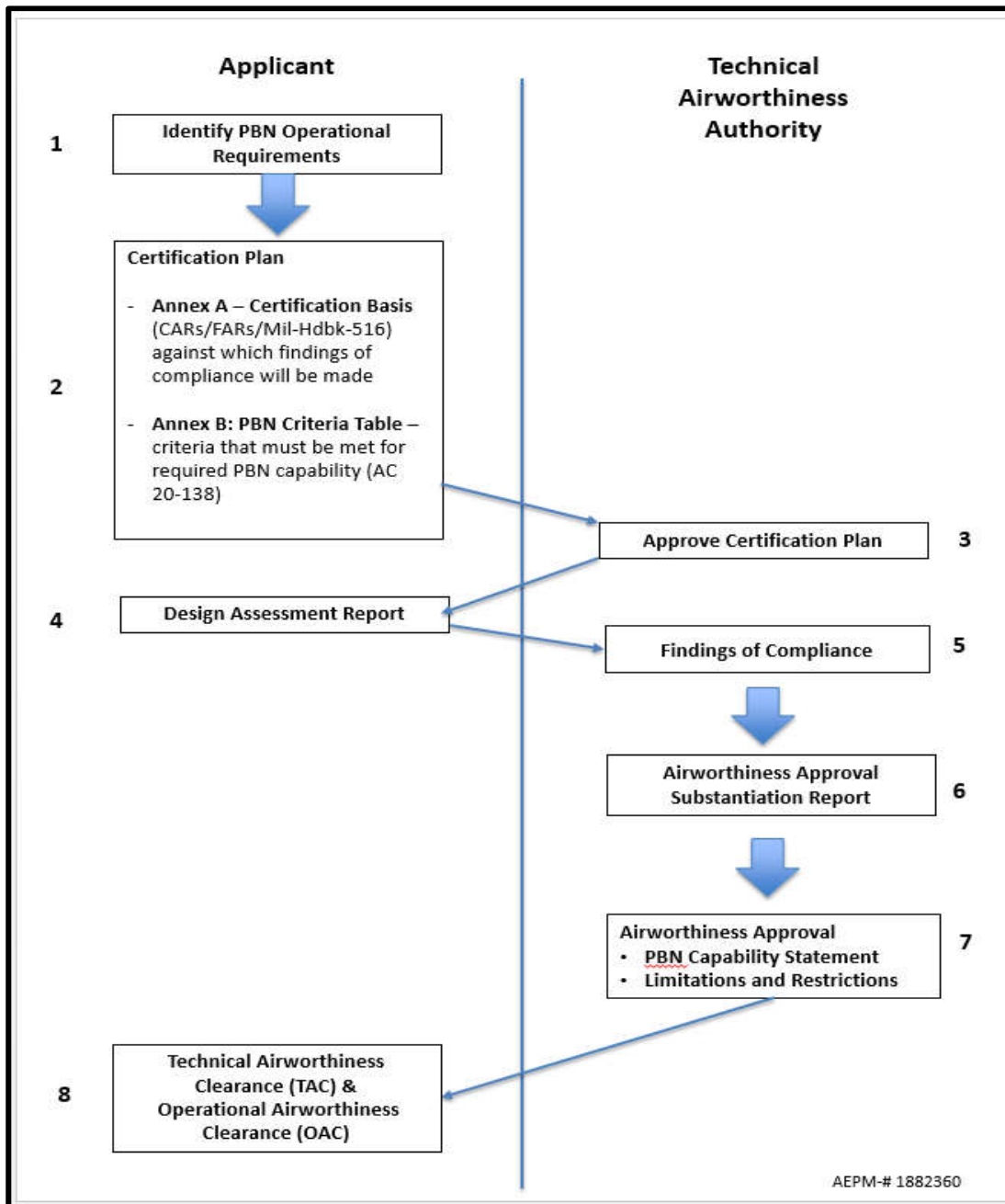


Figure1 – PBN Design Certification Process

b. **Step 2: Developing the Certification Plan, Certification Basis and PBN Criteria.** The applicant is responsible for preparing the certification plan, the certification basis and selecting the appropriate PBN criteria. Annex B provides guidance on the process of developing the certification plan, certification basis and PBN criteria table. This step consist of the following three sub-steps:

(1) **Step 2a: Developing the Certification Basis.** The certification basis will be composed of certification requirements selected from one of the approved civil or military

airworthiness codes identified in the ADSM, Part 1, Chapter 2, (regulatory reference 3.2.1.b). An example of a PBN certification basis is provided in Table B-1 of Annex B. This table identifies representative civil and military certification requirements that may be applicable to a PBN design.

- (2) **Step 2b: Drafting the Compliance Matrix.** As stated in para 3.3.5, AC 20-138D has been designated as the TAA's preferred means of demonstrating compliance to the PBN certification requirements. An example Compliance Matrix is provided in Table B-2 of Annex B.
  - (3) **Step 2c: Selecting the Applicable PBN Criteria.** A PBN Criteria Table is created by selecting the PBN criteria available in AC 20-138D that correspond to the RNP and RNAV capabilities identified in Step 1. The PBN Criteria Table will constitute the applicable set of PBN design and certification requirements for a specific PBN design. Advisory material for the PBN Criteria Table is provided in Annex C. Annex D provides additional technical criteria, beyond those provided in AC 20-138D.
- c. **Step 3: Obtaining TAA Approval of the Certification Plan.** The certification plan shall be submitted to the DTAES 3 Section Head for approval. It is recommended that the compliance matrix and PBN Criteria Table also be submitted for approval at the same time.
  - d. **Step 4: Preparing the Design Assessment Report.** Once the design has been developed and tested, it is recommended that the applicant prepare a Design Assessment Report to provide the TAA and finding authorities with a summary of the design and compliance data being submitted, to demonstrate that the certification requirements have been satisfied. Guidance material for developing the Design Assessment Report is available in Annex E.
  - e. **Step 5: Making Findings of Compliance.** The findings of compliance will be performed by DTAES 6 staff, or by other individuals authorized by the TAA. The role of the Finding Authorities (FAs) is to review the compliance program data and to determine if the design is compliant with the certification requirements.
  - f. **Step 6: Substantiation Report (optional).** A substantiation report may be required to summarize the work carried out by the TAA staff, in support of the airworthiness approval of the PBN capability. If required, the substantiation report will be prepared and staffed by the appropriate DTAES 3 Team Leader. Annex F provides guidance material for developing the report and determining when a report is required.
  - g. **Step 7: Airworthiness Approval.** DTAES 3 will issue the airworthiness approval of the PBN design, based on the completed compliance matrix, the findings of compliance and the Substantiation Report (if required). The airworthiness approval will include the following PBN specific sub-steps:
    - (1) **Step 7a: FM/AOI Updates.** The applicant, with the support of the DTAES 6 and DTAES 7 specialists, will prepare the required FM/AOI amendments, including the TAA/OAA approved PBN Capability Statement. Guidance material related to the FM/AOI updates is provided in Annex G.
    - (2) **Step 7b: PBN Capability Statement.** The TAC and OAC process for PBN requires that a PBN Capability Statement be developed, approved and inserted into in the FM/AOI. The PBN Capability Statement satisfies the requirements of Chapter 2,

section 3.6 of the RCAF *Flight Operations Manual*, which stipulates that the 'AOI or Flight Crew Operations Manual (FCOM) must explicitly state that the equipment meets the RNAV (or RNP) specifications.' Advisory material for the preparation of the capability statements is provided in Annex H.

- (3) **Step 7c: Limitations and Restrictions.** Any PBN-associated limitations or restrictions that will be included in the FM/AOI amendments must be approved by the TAA and the OAA.
  - (4) **Step 7d: Instructions for Continued Airworthiness (ICAs).** Any amendments to applicable ICAs that are associated with the PBN-related design change must be approved by a TAA Authorized Individual (AI). These include any maintenance requirements for the Magnetic Variation (MagVAR) tables and navigation databases.
- h. **Step 8: TAC and OAC Approval.** The final step in the PBN process is the approval of the TAC and the OAC, as follows:
- (1) For a new aircraft fleet, the PBN TAC approval will be included as a component of the main TAC issued by the TAA for the new fleet. For a PBN design change to an in-service fleet, the TAC will be issued by the WSM SDE.
  - (2) The OAC requirements are defined in the Operational Airworthiness Manual (OAM) (regulatory reference 3.2.1.c). Annex J identifies the specific PBN requirements that are applicable to the OAC.

#### **4.3 Navigation Database (NavDB) Support Arrangements.**

- 4.3.1 As identified in the ADSM, Part 3, Chapter 3 (regulatory reference 3.2.1.b), the aeronautical data support arrangements for the navigation databases required for PBN must be suitable for the intended use. The Type Certificate Holder organization is also required to develop a quality procedure that ensures that the applicable NavDB support requirements will continue to be met throughout the service life of the aircraft. Annex I provides advisory material for establishing the appropriate NavDB support arrangements.

#### **4.4 Additional Considerations Related to PBN Design Changes to Legacy Military Designs**

- 4.4.1 While it is expected that the PBN design certification process steps described in this advisory can be applied to the full range DND/CAF aircraft types, adding a PBN capability to legacy military avionics systems may result in certification issues that are not anticipated by the authors of AC-20-138D. Annex K provides guidance on techniques that may be applied to address legacy military aircraft design issues that may be encountered during the design and certification of a PBN capability.

## **Identifying the PBN Capability to Be Certified (Step 1)**

### **1. General**

- 1.1 This annex provides guidance on defining the specific PBN capabilities and functions that will be required to meet the operational requirements for a particular DND/CAF aircraft fleet.

### **2. Rationale and Guidance**

- 2.1 Since AC 20-138D (reference 3.2.2.a) is structured to accommodate multiple potential design configurations and PBN capability options, not all of the design and certification requirements in this AC will be applicable to a specific design.
- 2.2 The selection of the PBN capabilities and functions that will compose the PBN design to be certified will be used to develop the certification plan, and choose the certification requirements and means of compliance from AC 20-138D (advisory reference 3.2.2.a).
- 2.3 During the process of identifying the required PBN capabilities, the following must also be defined and documented:
- a. **Operational Requirements.** The high-level PBN operational requirements provided by the RCAF Air Staff should include the following information:
    - (1) The PBN capabilities required, e.g., RNAV 1, RNAV 2, RNAV 5, RNP 1, RNP 2, RNP 4, RNP APCH, etc.
    - (2) The countries, areas and airspace of the world where the capability will be used; and
    - (3) Any specific differences in the way the capability will be used by the DND/CAF, as opposed to civil aviation counterparts, such as: military unique approach profiles, use of PBN during formation flying and air-to-air refuelling, etc.
  - b. **PBN Capability Description.** Based on the operational requirements provided by the RCAF Air Staff, the applicant (with assistance from the DTAES 6 engineering support staff) must develop a description of the required aircraft design changes. The description should identify the PBN capabilities and functions to be certified, including a description of how these PBN functions will be realized using both the existing, and any new, aircraft avionics systems. This information should be included in the Certification Plan.
  - c. **Aircraft Avionics Architecture.** The applicant must provide a description of how the required PBN capabilities will be realized using the existing aircraft avionics systems or replacement systems.
- 2.4 The capability description will be used by the DTAES 3 and DTAES 6 staff to define the PBN certification requirements that will form the design certification basis. The PBN capability description document should include the following:
- a. Identification of each applicable ICAO PBN navigation specification (advisory reference 3.2.2.b), e.g. RNP 4, RNP 2, RNP APCH or RNAV. Any optional performance, or functionality feature that will be required must be identified.
  - b. Usage of same terminology and vocabulary found in the ICAO PBN Manual (advisory reference 3.2.2.c), such as “remote airspace”. Alternate terminology that may be used in Canada, or by DND, such as Northern Domestic Airspace in Canada, is allowed.
  - c. Identification of the specific navigation functions and applications that are required, such as RNP Approach to LP or LPV minima.



## **Certification Plan and Certification Basis (Steps 2a and 2b)**

### **1. General**

1.1 This annex provides guidance on developing the PBN certification plan and certification basis.

### **2. Rationale and Guidance – Certification Plan**

2.1. The applicant is responsible for developing the certification plan and submitting it to DTAES 3 for approval. DTAES 3 will staff the plan to DTAES 6 for the review of the PBN technical aspects of the plan, specifically the certification basis, means of compliance and PBN Criteria Table. During the development of the plan, it is recommended that the applicant consult DTAES 6 staff for assistance.

2.2 In addition to the standard certification plan requirements defined in the TAM, Parts 2 and 3 (regulatory reference 3.2.1.a), the plan must include the following:

- a. the currently approved type design and any approved PBN capabilities;
- b. the new PBN capabilities to be certified (Step 1);
- c. the current and proposed aircraft navigation system equipment configuration and nomenclature to be approved, including any differences across the fleet;
- d. any operating configurations and equipment restrictions that affect PBN capabilities, including those for mission equipment and external stores. This information is used to determine the scope of compliance demonstration tests and analyses;
- e. the proposed certification basis (Step 2a); and
- f. how AC 20-138D will be applied to develop the compliance program.

### **3. Rationale and Guidance – Certification Basis**

3.1 As described in paragraph 4.2.1.b.(1) of the advisory, the certification requirements that will form the certification basis must be selected from one of the approved civil or military airworthiness codes identified in the ADSM (regulatory reference 3.2.1.b).

3.2 Table B-1 provides a listing of the certification requirements that should be considered when defining the certification basis for a PBN design change.

### **4. Rationale and Guidance – Means of Compliance**

4.1 As described in the ADSM (regulatory reference 3.2.1.b), paragraph 3.3.7.13, the TAA has adopted AC 20-138D as the TAA's preferred means of demonstrating compliance with the PBN certification requirements. However, this does not encompass the publication in its entirety. FAA Advisory Circular 20-138D is a large and complex document, designed to address a broad range of navigation equipment and capabilities. As a result, not all of the criteria in the AC will be applicable to any particular design.

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**Table B-1 Example of Certification Requirements from Civil and Military Airworthiness Codes to Be Used in Developing the Certification Basis for a PBN Design Change**

No.	Civil Airworthiness Codes	Military Airworthiness Codes (Mil-Hdbk-516, EMACC)
1	AWM/FAR xx.581 Lightning Protection	13.2.4 Lightning Protection
2	AWM/FAR xx.899 Electrical bonding and protection	12.2 Electrical Power Distribution, Bonding and Grounding
3	AWM/FAR xx.1301 Function and Installation	11.1.1 Avionics Subsystems Architecture 11.1.1.5 Navigation subsystem.
4	AWM/FAR xx.1307 Miscellaneous equipment.	11.1.1 Avionics subsystems architecture.
5	AWM/FAR xx.1309 Equipment, Systems and Installations	11.1 Undetected failure modes, Redundancy, Deterministic 11.2 Safety and flight critical control functions, Integrity. 14.1.1 System safety, Fail-safe design 14.2. Safety Design Requirements, Single point failure 14.3 Software safety program. 15. Computer Systems and Software
6	AWM/FAR xx.1310 Power Source Capacity and Distribution	12.1 Electrical Power Generation 12.2 Electrical Wiring and Power Distribution
7	AWM/FAR xx.1316 Electrical and Electronic System Lightning Protection	13.2.4 Lightning Effects
8	AWM/FAR xx.1317 High-intensity Radiated Fields (HIRF) Protection	13.1 Component/subsystem E3 qualification 13.2 System-level E3 qualification
9	AWM/FAR xx.1321 Flight Instrument - Arrangement and Visibility	9.2.1 Crew station arrangement. 9.2.1.1 Controls and display readability. 9.2.2 Controls and display usability
10	AWM/FAR xx.1322 Flight Crew Alerting	9.2.3 Aircrew alerting systems. 11.2.1.3 Warnings, cautions, and advisories
11	AWM/FAR xx.1325 Static pressure systems	11.1.1.1 Air data system.
12	AWM/FAR xx.1329 Flight Guidance Systems	6.1.13 Characteristics of secondary flight control systems. 6.2 Vehicle control functions (VCF).
13	AWM/FAR xx.1331 Instruments using a power supply	12.1.5 Uninterruptible power
14	AWM/FAR xx.1333 Instrument systems	9.2.1 Crew station arrangement. 9.2.1.1 Controls and display readability. 9.2.2 Controls and display usability
15	AWM/FAR xx.1351 Electrical Systems and Equipment -General	12.1 Electrical Power Generation 12.1.4 Power quality
16	AWM/FAR xx.1353 Electrical equipment and installations	12.1.3 Safe operation of integrated electrical power system.
17	AWM/FAR xx.1357 Circuit protective devices	12.2.3 Circuit protection
18	AWM/FAR xx.1419 Ice protection	8.2.9.1 Ice detection and protection.
19	AWM/FAR xx.1431 Electronic equipment	11.1.5.3 Interface/interconnect failures 11.2.5 Electrical power quality
20	AWM/FAR xx.1529 Instructions for Continued Airworthiness	16.1 Maintenance manuals/checklists. 16.2 Inspection requirements.
21	AWM/FAR xx.1533(b) Additional operating limitations	11.3.2 Necessary limitations
22	AWM/FAR xx.1581(a)(2) Airplane Flight Manual	11.3.2 Necessary limitations. 12.1.7 Subsystem limitations. 12.1.8 Procedures

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- 4.2 The recommended approach is to identify the appropriate criteria from AC 20-138D for the required PBN capabilities defined in Step 1 – Identifying the PBN Capabilities to Be Certified. Once identified, the criteria should be collated to create the PBN Criteria Table, as described in Step 2c – Setting up the PBN Criteria Table.
- 4.3 Specialist knowledge and experience are required to interpret and select the appropriate criteria. The DTAES 6 engineering support staff should be engaged to assist in the selection of the applicable criteria and the development of the PBN Criteria Table. Guidance material for the development of the PBN Criteria Table is provided in Annex C.
- 4.4 The final step in demonstrating compliance is the identification of compliance artefacts, which will be provided to support the findings of compliance and design assessment. Examples of compliance artefacts include:
- a. Design description documents;
  - b. Design analysis reports;
  - c. Integration lab test reports;
  - d. Aircraft ground and flight test reports;
  - e. Technical Standard Order (TSO) Authorization (TSOA) or Military Standard Order (MSO) approval references; and
  - f. Approvals from other Airworthiness Authorities.
- 4.5 Table B-2 provides an example PBN certification basis and compliance matrix.

**Table B-2 Example of PBN Certification Basis and Compliance Matrix**

Certification Basis			Means of Compliance	Compliance Artefacts	Finding Authority
Certification Requirement and Title	Certification Requirement Text	Notes			
FAR xx.1301 Function and Installation	Each item of installed equipment must— (a) Be of a kind and design appropriate to its intended function; (c) Be installed according to limitations specified for that equipment; and (d) Function properly when installed.		AC 29.1301 and the applicable portions of AC 20-138D, as defined in the Criteria Table	<ul style="list-style-type: none"> <li>• Design Data, Analysis and Test Reports</li> <li>• Design Assessment Report</li> </ul>	FA Avionics and Software
FAR xx.1309 Equipment, Systems and Installations	The equipment, systems, and installations whose functioning is required by this subchapter, must be designed to ensure that they perform their intended functions under any foreseeable operating condition.		AC 25/29.1309 and applicable portions of AC 20-138D, as defined in the Criteria Table	<ul style="list-style-type: none"> <li>• Design Data, Analysis and Test Reports</li> <li>• Design Assessment Report</li> </ul>	FA Avionics and Software
FAR xx.1309 Equipment, Systems and Installations	The airplane systems and associated components, considered separately and in relation to other systems, must be designed so that— (1) The occurrence of any failure condition which would prevent the continued safe flight and landing of the airplane is extremely improbable, and (2) The occurrence of any other failure conditions which would reduce the capability of the airplane or the ability of the crew to cope with adverse operating conditions is improbable.		AC 25/29. and applicable portions of AC 20-138D, as defined in the Criteria Table	<ul style="list-style-type: none"> <li>• Design Data, Analysis and Test Reports</li> <li>• Design Assessment Report</li> </ul>	FA Avionics/ Software and System Safety
FAR 25.1310/ Power Source and Distribution	Each installation whose functioning is required for type certification or under operating rules and that requires a power supply is an “essential load” on the power supply. The power sources and the system must be able		Applicable portions of AC 20-138D, as defined in the Criteria Table	<ul style="list-style-type: none"> <li>• Design Data, Analysis and Test Reports</li> </ul>	FA Electrical

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Certification Basis			Means of Compliance	Compliance Artefacts	Finding Authority
Certification Requirement and Title	Certification Requirement Text	Notes			
	to supply the following power loads in probable operating combinations and for probable durations			<ul style="list-style-type: none"> <li>Design Assessment Report</li> </ul>	
Mil Hdbk 516 section 13.2.4 Lightning Effects	516-Criterion: Verify that the air system has met all requirements for lightning, either direct (physical) or indirect (electromagnetic) effects and that any potential for ignition of fuel vapors is eliminated.	Or FAR xx.1316 Lightning Protection	AC 20-136B or Mil Std 464 and applicable portions of AC 20-138D, as defined in the Criteria Table	<ul style="list-style-type: none"> <li>Design Data</li> <li>Design Assessment Report</li> </ul>	FA E3
FAR 25.1317 High-intensity Radiated Fields (HIRF) Protection.	Each electrical and electronic system that performs a function whose failure would prevent the continued safe flight and landing of the airplane must be designed and installed so that— (1) The function is not adversely affected during and after the time the airplane is exposed to HIRF environment I, as described in appendix L to this part:[...]		Applicable portions of AC 20-138D, as defined in the Criteria Table	<ul style="list-style-type: none"> <li>Design Data, Analysis and Test Reports</li> <li>Design Assessment Report</li> </ul>	FA E3
FAR xx.1321 Flight Instruments	Each flight, navigation, and power plant instrument for use by any pilot must be plainly visible to him from his station with the minimum practicable deviation from his normal position and line of vision when he is looking forward along the flight path.		AC 29.1321 and applicable portions of AC 20-138D, as defined in the Criteria Table	<ul style="list-style-type: none"> <li>Design Data, Analysis</li> <li>Design Assessment Report</li> </ul>	FA TN – Avionics/HFE
FAR xx.1322 Flight Crew Alerting	Flight crew alerts must: (1) Provide the flight crew with the information needed to: (i) Identify non-normal operation or airplane system conditions, (ii) Determine the appropriate actions, if any. (2) Be readily and easily detectable and intelligible by the flight crew under all foreseeable operating conditions, including conditions where multiple alerts are provided. (3) Be removed when the alerting condition no longer exists		AC 25/29.1322 and applicable portions of AC 20-138D, as defined in the Criteria Table	<ul style="list-style-type: none"> <li>Design Data, Analysis and Test Reports</li> <li>Design Assessment Report</li> </ul>	FA Avionics
FAR xx.1581 Flight Manual	An Airplane Flight Manual must be furnished with each airplane, and it must contain the following: (1) Information required by §§25.1583 through 25.1587; (2) Other information that is necessary for safe operation because of design, operating, or handling characteristics.		AC 25/29.1581 and applicable portions of AC 20-138D, as defined in the Criteria Table	<ul style="list-style-type: none"> <li>Design Data, Analysis and Test Reports</li> <li>Design Assessment Report</li> </ul>	FA AFM
FAR xx.1529	Instructions for Continued Airworthiness (ICAs)		TAA Advisory 2019-05 and applicable portions of AC 20-138D, as defined in the Criteria Table	<ul style="list-style-type: none"> <li>Reports</li> </ul>	DTAES 4

## **PBN Criteria Table (Step 2c)**

### **1. General**

1.1 This annex provides guidance on developing the PBN Criteria Table.

### **2. Rationale and Guidance**

- 2.1 As described in paragraph 4.2.1.b.(3), Step 2c, of the advisory, the PBN Criteria Table identifies the applicable AC 20-138D (reference 3.2.2.a) criteria and means of compliance that will be used to certify the PBN design. The PBN Criteria Table is created by selecting those criteria and means of compliance that correspond to the specific RNP and RNAV capabilities identified in Step 1.
- 2.2 The PBN Criteria Table will be submitted to the TAA for approval. It is recommended that the table be submitted with the certification plan. However, if necessary, the table may be submitted at a later date.
- 2.3 Annex D identifies additional technical criteria that the TAA has provided to supplement the criteria in AC 20-138D. The additional criteria should be included in the PBN Criteria Table, as appropriate.
- 2.4 The criteria in the table will be used to evaluate the PBN design using the appropriate means of compliance identified in the compliance matrix.
- 2.5 It is recommended that assistance with developing the Criteria Table be requested from DTAES 6 engineering support staff.
- 2.6 The following should be considered in developing, and obtaining approval of, the PBN Criteria Table:
- a. A detailed table is key to the successful certification of a PBN capability. It should be structured around the following information:
    - (1) the applicable AC 20-138D criteria and the way they were allocated against the requested PBN capabilities defined during Step 1;
    - (2) the aircraft avionics components to which the approval will apply; and
    - (3) the operating modes of the navigation and flight management systems for the PBN capabilities defined during Step 1.
  - b. The PBN Criteria Table should identify the criteria corresponding to each of the discrete PBN capabilities to be certified.
  - c. Where any criteria have been satisfied by prior certification, and continue to be met by the design change, this may be indicated in the comments section of the Criteria Table and a reference provided in the compliance matrix.
  - d. The table should include the reasons for excluding any portions of AC 20-138D criteria that would otherwise be expected to apply.
  - e. AC 20-138D uses mandatory terms, such as “must”, that are only applicable when the means of compliance that the applicant chose to follow are recommended in the AC. The AC also uses ‘non-mandatory’ terms, such as “should” or “recommended”, to identify other acceptable means of compliance that applicants are encouraged to use, but are not mandated. The term “may” is used for optional methods.
  - f. The TAA recommends that the ‘non-mandatory’ criteria be considered for inclusion in the PBN Criteria Table. The FAA’s reason for including non-mandatory criteria in the AC is to provide an increased design level of safety. For example, the AC recommends

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that “the course selector of the deviation display be automatically slewed to the RNP computed path.” This feature is not mandatory for design approval, but it is recommended that it be assessed, and that any conditions that may prevent the criterion from being met be documented in the PBN Design Assessment Report. When a non-mandatory criterion is applied, it should be identified in the Criteria Table as ‘not mandatory.’

2.7 **Example of a PBN Criteria Table.** Table C-1 is a sample PBN Criteria Table. The table is developed based upon the information available in the certification plan that defines the following:

- a. the design to be certified (the currently approved type design and the equipment changes); and
- b. the PBN capabilities to be certified, both the current and new PBN capabilities.

**NOTES**

1. *Use ICAO Doc 9613, Ed 4, Table II-A-1-1 terminology for navigation specifications and flight phases.*
2. *The equipment nomenclature and PBN capabilities defined in the certification plan must be identical to the nomenclature and PBN capability phrasing in the PBN Criteria Table.*

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**Table C-1 – Example PBN Criteria Table**

Criterion # (AC 20-128D)	PBN Capability	Flight Phase	Equipment Operating Mode	Criterion Text	Compliance Technique	Compliance Notes	Results (Met / Not Met)	Comments
12-8 (Title)				Final Approach Segment Step-Down Fixes in Navigation Databases				
12-8 (a)				[...] the database must include all named waypoints that make up the instrument approach procedure except for final approach segment step-down fixes. Showing step-down fixes on a vertical profile display can enhance flight crew situation awareness, but can also complicate installation issues (see paragraphs 12-8.b through 12-8.d).		This Criteria Table constitutes contact with the DND certification authority. Approval requested for the onboard navigation database to contain step-down fixes.		
12-8 (b)	<b>RNP APCH</b> Part A (GNSS) <b>RNP APCH</b> Part B (GPS SBAS)	All approach segments	See PBN Capability Description	Equipment manufacturers providing final approach segment step-down fixes in their onboard navigation databases for RNAV (GPS) approach procedures must either provide a method to remove them or provide an installation limitation for cockpit configurations that cannot properly support them (i.e., define the requirements in the installation instructions/manual).	Inspection	The Flight Management System (FMS) installation instructions contain criteria for the cockpit configuration. Each MFD will be assessed using the criteria in the FMS installation instructions.		
12-8 (c) (excluding subparas)	<b>Same as above</b>	All approach segments	See PBN Capability Description	[...] The airworthiness applicant must ensure the displayed RNAV(GPS) approach is in the primary field of view, in the proper sequence, unambiguous, and does not create detrimental clutter.	Inspection	As above.		
12-8 (c)(2)	<b>Same as above</b>	All approach segments	See PBN Capability Description	When installing equipment with final approach segment step-down fixes in the onboard navigation database, the display integration must: <ul style="list-style-type: none"> <li>• Be accessible and readable by all required flight crewmembers;</li> <li>• Clearly depict and label the aircraft's track;</li> <li>• Clearly label displayed waypoints, fixes and numeric information with sufficient detail to enable a pilot to discern a step-down fix from other fixes on a procedure.</li> </ul>	Inspection	As above.		
A12-8 c (3) First criterion	<b>Same as above</b>	All approach segments	See PBN Capability Description	The suggested optimum implementation is showing final approach segment step-down fixes for LNAV and LP approaches, but not showing final approach segment step-down fixes during an LNAV/VNAV or LPV approach.	Flight Test	Final approach segment step-down fixes are displayed during LNAV/VNAV approaches. They are not displayed during an LPV approach.		
12-8 c (3) second criterion	<b>Same as above</b>	All approach segments	See PBN Capability Description	[...] When displaying distance/bearing/track to a step-down fix on the LPV final approach segment (i.e., after crossing the final approach fix), the equipment must also provide a readily available, clear, unambiguous indication of distance/bearing/track to the LTP/FTP. Due consideration should be given to the cockpit configuration and display capabilities during the airworthiness approval process.	Flight Test	The MAP page shows the step-down fix name, distance and track in a callout box attached to the fix. The feature is not selectable. Non-interference with LPV path construction will be demonstrated in flight.		
12-8 (d)	<b>Same as above</b>	All approach segments	See PBN Capability Description	[...] airworthiness applicants must include language for a limitation in the AFM(S)/ RFM(S) (or equivalent documentation) requiring the flight crew to use the primary barometric altimeter to comply with a final approach segment step-down fix altitude restriction during an LNAV, LP, or non-ILS conventional approach. [...]	AFM	This is a limitation in the current AFM.		
TAA Advisory 2019-05, Additional Technical Criteria	<b>Same as above</b>	All approach segments	See PBN Capability Description	5. Inoperative Equipment. The effect of inoperative equipment on the PBN capability must be assessed and if necessary addressed by AFM limitations, or the MEL.	Inspection	Display of step-down fixes will be assessed with any one MFD inoperative.		

## **Additional Technical Considerations**

### **1. General**

- 1.1 This annex identifies additional technical considerations and criteria provided by the TAA to supplement those selected from AC 20-138D (reference 3.2.2.a). Not all of these considerations may be applicable to a specific design approval.

### **2. Rationale and Guidance**

- 2.1 The following additional technical considerations apply to the certification of a PBN design:
- a. **Containment.** If the PBN capability is being added to an existing avionics design, the Design Assessment Report developed in Step 4 should review the prior certification records for the design, including:
    - (1) existing exemptions and deviations;
    - (2) service history;
    - (3) operating procedures; and
    - (4) existing Flight Manual/Aircraft Operating Instructions (FM/AOI) limitations and capability statements.
  - b. **Unique Designs.** The aircraft may have navigation capabilities for which there are no navigation performance criteria in AC 20-138D, such as inertial coasting. As a minimum, the performance of these navigation capabilities must be substantiated and addressed by the containment continuity and containment integrity analysis, or limitations applied when appropriate.
  - c. **Baro VNAV to High-Elevation Aerodromes.** Baro VNAV capability statements that are based on the criteria of AC 20-138B or AC 20-129 (reference 3.2.2.j) must have an AFM limitation prohibiting Baro VNAV approach procedures to airfields above 6,000 feet MSL. This is consistent with EASA Safety Information Bulletin (SIB) 2014-04, 'RNP Approach with Baro-VNAV' (reference 3.2.2i). The EASA SIB accepts certification to FAA AC 20-129 for European operational approval up to a field elevation of 6,000 feet MSL. Section 7 of EASA Certification Memo (CM) AS-002 Issue: 02, dated 28 March 2014 (reference 3.2.2.k), discusses the matter in detail and suggests operational mitigations.
  - d. **Inoperative Equipment.** The effect of inoperative equipment on the PBN capability must be assessed and, if necessary, addressed by the FM/AOI limitations, or the Master Minimum Equipment List (MMEL).
  - e. **Aircraft-based Augmentation.** AC 20-138D, paragraph 15-6 b identifies the requirement for a performance limitation in the AFM when equipment uses an aircraft-based augmentation system, such as RAIM (e.g., TSO C129a and C196 GNSS equipment). The limitation is to have other navigation equipment available, which is appropriate to the operation, including selecting an alternate airport. In addition, this FM limitation must address the current expectations of AIP Canada (ICAO) ENR 4.3 and RCAF Flight Operations Manual.
  - f. **Pre-Flight RAIM Prediction Software.** When required for the intended operations, Receiver Autonomous Integrity Monitoring (RAIM) prediction software and user manual used to predict GPS RAIM and Fault Detection and Exclusion (FDE) coverage for the



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route to be flown must be assessed and identified in the FM/AOI. Criteria are provided in AC 20-138D 5-2.3.

- g. **Adverse Effects of Mission Equipment or Stores.** The effect of military equipment on the PBN capability must be assessed, or equipment operation restricted. Consideration should be given to external stores, display of tactical data and formats, intercom modes and transmitter operation.
- h. **Magnetic Variation (MagVar) Data.** AC 20-138D, Change 2, paragraph 12-9.b specifies that any operating limitations must be identified and documented for installed avionics systems associated with the application of magnetic variation data (e.g., operations using magnetic heading references may only be valid between 82° north latitude and 82° south latitude) to ensure that accurate magnetic heading references are presented and used in the aircraft. Continuing airworthiness requirements should be defined to identify the need to update the magnetic variation database and, if applicable, conversion algorithms or hardware, when periodic updates become available. This requirement should also define the maintenance procedures necessary to update the on-board magnetic variation database for installed avionics systems.

## **Design Assessment Report (Step 4)**

### **1. General**

- 1.1 This annex provides guidance on the development of the Design Assessment Report that is identified in the main body of this advisory under Step 4 of the PBN Design Certification Process.

#### **NOTE**

*Although the applicant is responsible for providing the TAA with the Design Assessment Report, it is recommended that the applicant seek the assistance of the DTAES 6 engineering support staff for the report development.*

### **2. Rationale and Guidance**

- 2.1 The primary purpose of the Design Assessment Report is to summarize the results from the compliance program and provide the TAA and finding authorities with references to the design description documents and compliance artefacts. The assessment report will be used as a roadmap to assist the Finding Authorities (FAs) during their evaluation of the compliance data. The report should be written and structured to provide the TAA and finding authorities with the information they require in making their findings.
- 2.2 The Design Assessment Report should include the following information:
- a. the PBN capabilities that are proposed for approval, including any limitations;
  - b. the aircraft avionics systems configuration;
  - c. the navigation sensors and the operating modes of the navigation and flight control systems, including those the use of which is prohibited;
  - d. the means of compliance used, including the use of existing approvals and data for similar products;
  - e. any recommended restrictions and limitations on the capability when a particular criterion has been assessed for only a subset of equipment modes and flight phases;
  - f. where existing equipment approvals have been applied;
  - g. the extent to which an existing design was modified to meet the equipment and installation criteria for PBN;
  - h. any interpretation of the PBN criterion used during the assessment (agreed interpretations are generally established through approval of the PBN Criteria Table);
  - i. any aspects of the design that do not meet, or only partially meet, the mandatory and non-mandatory criteria;
  - j. any design changes required to remove each limitation placed on a PBN capability;
  - k. any areas where an 'Equivalent Level of Safety' finding has been used, or when an alternate means of compliance has been used to show that a criterion has been met;
  - l. any areas where an 'Acceptable Level of Safety' assessment has been used to recommend approval, in lieu of showing that a criterion has been met; and
  - m. any possible or recommended mitigating actions that will be required as a result of the use of an ALOS argument, or airworthiness limitations/restriction, to approve the design.
- 2.3 Prior to providing the report to the Finding Authorities, it should be reviewed by DTAES 6-4 to obtain an endorsement of the report conclusions and recommendations.

## **Substantiation Report (Step 6)**

### **1. General**

1.1 This annex provides guidance on the development of a substantiation report identified in this advisory under Step 6 (paragraph 4.2.1.f) of the PBN Design Certification Process.

### **2. Rationale and Guidance**

2.1 The role of the substantiation report is to document any compliance issues, validate any claims of Equivalent Level of Safety (ELOS)/ Acceptable Level of Safety (ALOS) and explain to the TAA and OAA the rationale behind any restrictions or limitations that the TAA staff are proposing.

2.2 Examples of compliance issues may include:

- a. Failure to meet some of the PBN criteria, either in whole or part;
- b. Findings of ELOS;
- c. Use of an ALOS argument to support the airworthiness approval; and
- d. Request for an exemption to a certification requirement.

2.3 DTAES 3 is responsible for determining whether or not a substantiation report is required and will coordinate the report with DTAES 6.

2.4 A substantiation report may not be required if the airworthiness approval can be granted based only on the completed compliance matrix, and if the Finding Authorities (FAs) are able to successfully complete all of their findings. This assumes that there are no certification issues to be resolved, nor any requirement to base the approval on an ALOS assessment.

2.5 Compliance issues typically arise during the following stages of the PBN Design Certification Process, and may need to be addressed in the substantiation report:

- a. **Design Assessment** (Step 4). Examples of issues that that may be identified during the design assessment phase and need to be documented in the substantiation report include:
  - (1) lack of adequate compliance artefacts to make a conclusive assessment that the PBN criteria have been met;
  - (2) missing or inappropriate PBN criteria selection;
  - (3) claims that the design meets the ELOS or ALOS criteria;
  - (4) lack of information to adequately support an ELOS claim;
  - (5) lack of information to support an ALOS claim;
  - (6) proposals to use limitations, restrictions or 'operational/aircrew' procedures to compensate for design deficiencies, or to compensate for areas of non-compliance; and
  - (7) requests for exemptions or deviations to the certification requirements.
- b. **Findings of Compliance** (Step 5). Issues that may be raised by the FAs and require resolution in the substantiation report include:

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- (1) lack of adequate proof of compliance data to make a finding of compliance to the requirement specified in the certification basis;
  - (2) FA's comments and/or recommendations to address any issues or design deficiencies identified in the Design Assessment Report;
  - (3) restrictions and/or limitations recommended by the FA; and
  - (4) FA's assessment of any ELOS or ALOS arguments that are used in the recommendation for approval of a design.
- 2.6 Advisory material related to the use of ELOS and ALOS as methods to address certification issues related to PBN design approval may be found in the 'CNS/ATM Policy Interpretation' section of reference regulatory reference 3.2.1.b., Part 3, Chapter 3, paragraph 3.3.6.
- 2.7 The following two substantiation report examples are available to DTAES staff:
- a. CH146 Area Navigation Airworthiness Substantiation Report (available internally, within DND, at AEPM RDIMS #1865469)
  - b. CF188 Area Navigation Airworthiness Approval Substantiation Report – Initial Issue, 2 Nov 2018 (available internally, within DND, at AEPM RDIMS #1826138)

## Updates to Flight Publications Flight Manual (FM)/Aircraft Operating Instructions (AOI) (Step 7a)

### 1. General

- 1.1 This annex provides additional considerations for the development of updates to the FM and AOI, as required in Step 7(a) of the PBN Design Certification Process (paragraph 4.2.1.g.(1) of the advisory).

### 2. Rationale and Guidance

- 2.1 The development of FM/AOI updates will be based on the following considerations:
- a. The applicant, in concert with the applicable DTAES 3 Team Leader and the DTAES 6-4 and DTAES 7-6 specialists, will prepare and recommend the approval of the required FM/AOI updates.
  - b. **PBN Capability Statement.** As described in Step 7b of the PBN Design Certification Process (paragraph 4.2.1.g.(2) of the advisory), the approved capability statement is part of the FM/AOI update. The PBN capability statement meets the requirement for navigation equipment certification statements stipulated in the RCAF Flight Operations Manual (reference 3.2.2.1), Chapter 2, para 2.3.6.2. Annex H of this advisory provides additional guidance on developing the capability statements.
  - c. **Limitations and Restrictions.** As described in Step 7c of the PBN Design Certification Process (paragraph 4.2.1.g.(3) of the advisory), and in accordance with the Operating Limitations section of the TAM (regulatory reference 3.2.1.a), Part 2, Chapter 7, Flight Publications, any additional limitations and restrictions associated with the PBN design approval must be approved by the TAA and inserted into the FM/AOI. Several of the criteria in AC 20-138D (reference 3.2.2.a) and the Additional Technical Considerations described in advisory Annex D may require that limitations and information notes be added to the FM/AOI. The following is an example of a PBN limitation that was added to the CP140 FM/AOI:

“The Block 1A configuration is not approved for lateral offsets. The Block 1A avionics configuration does not provide timely alerting prior to automatic termination of the offset at a transition waypoint.”
  - d. **Operating Procedures.** The PBN-related operating procedures that are included with the FM/AOI are approved by the TAA and OAA during the Airworthiness Clearance process.
  - e. **PBN System Functional Description.** An example of a PBN System Functional Description is:

“The integrity of the navigation solution of the INS will be valid following loss of the GNSS receiver after loss of a single satellite. The validity of the INS solution following the loss of multiple satellites in a jamming environment has not been assessed, so crews should use opportunities to check the INS navigation solution when jamming is the suspected cause of GPS signal loss.”

## PBN Capability Statements (Step 7b)

### 1. General

- 1.1 This annex provides guidance on the development of the PBN Capability Statements to be inserted into the FM and AOI, as required in Step 7(b) of the PBN Design Certification Process (paragraph 4.2.1.g.(2) of the advisory).

### 2. Airworthiness Requirements

- 2.1 The requirement for capability statements originates in the following regulatory provisions:

- a. **RCAF Flight Operations Manual** (reference 3.2.2.1), Chapter 2, Paragraph 2.3.6.2, requirements for navigation equipment certification statements, stipulates:

**'Aircraft Equipment Certification.** RNAV (GNSS) navigation must be operationally airworthy and certified by 1 Cdn Air Div HQ. The respective AFM, AFM supplement, AOI or FCOM must explicitly state that the equipment meets the specifications as detailed in ... this section in order to be approved for RNAV (GNSS) operations.'

- b. **AC 20-138D** (reference 3.2.2.a). Paragraph 12-7, Equipment Capability and Installed Limitations, of Chapter 12, stipulates:

**'Equipment Capability and Installed Limitations.** Airworthiness approval holders should include a comprehensive PBN statement of capabilities and qualification in the AFM(S)/RFM(S) describing the aircraft's PBN capabilities and operations limitations as an easy reference for flight crews and authorities that grant operations approvals. Doing so can greatly ease the process for operators that need operations approvals and enhance flight crew awareness of the aircraft's PBN capability.'

- 2.2 As described in Step 7b of the PBN Design Certification Process, the TAA and the OAA require that PBN Capability Statements be developed, approved and inserted into the FM/AOI. The capability statements provide the aircrew with a concise summary of the aircraft's approved PBN capabilities and limitations, and are meant to be used by them in the preparation of flight plans and ATC clearance requests. The PBN capability statements may refer to the system description and operating procedures contained in the FM/AOI.
- 2.3 Once the design assessment (Step 4) has been completed, the PBN Capability Statements should be drafted and made available to the finding authorities (FAs), to provide them with a summary of the proposed capabilities and limitations arising from the assessment. In their Technical Notes, the FAs will be required to make a recommendation to the TAA regarding the approval of the wording in the capability statements.
- 2.4 The PBN capability statements will be approved as part of the TAC and OAC approval process. Once the capability statement has been approved by the TAA and OAA, the Weapon System Management organization is responsible for inserting the statements into the FM/AOI.
- 2.5 The format of the capability statements should be consistent with the format and structure of the existing FM/AOI. Subsequent changes to the statements are subject to the Technical Airworthiness Data (TAWD) change approval process described in the TAM (regulatory reference 3.2.1.a).

**3. PBN Capability Statement Example**

- 3.1 Figure H-1 provides an example PBN capability statement to illustrate the type of information that could be included in the FM/AOI, following the approval of a design change: the addition of a RNP 1 capability.

Approved Technical Airworthiness Data
<b>PBN Capability Statement</b>
<b>Approved Capability: RNP 1</b>
This Block 2 FMS installation complies with the TAA requirements for RNP 1 (as derived from FAA AC 20-138D, Change 2) and is eligible for operational approval consistent with ICAO Performance Based Navigation (PBN) Manual RNP 1, including RF legs, in the following minimum operating configurations:
<ul style="list-style-type: none"><li>• Single FMS in GPS, DME/DME or IRS (time limited) Navigation Mode</li><li>• Coupled to AP and/or FD.</li><li>• VOR/DME mode deselected (to prevent automatic switching to this mode upon loss of GPS).</li><li>• Time limit for FMS in IRS Navigation Mode (following a GPS or DME/DME mode failure) is 30 minutes after the FMS enters the IRS Navigation Mode.</li></ul>

**Figure H-1 Example of a PBN Capability Statement**

- 3.2 As illustrated in Figure H-1, the PBN capability statement includes the following information:
- a. the ICAO navigation specification (RNP 1);
  - b. the equipment providing the navigation capability (Flight Management System (FMS) and Block 2 avionics);
  - c. the source document for the criteria used to assess the aircraft (FAA AC 20-138D, Change 2);
  - d. the operating configuration (at least one coupled FMS, and the VOR/DME Navigation Mode deselected); and
  - e. the exact text that is approved by the TAA (inside the box).
- 3.3 The approved PBN capability statements should speak only to the performance of the equipment, the supporting software and navigation databases. The operational requirements of the ICAO PBN Manual should not be included in the portion of the FM that is approved by the TAA.
- 3.4 It is strongly recommended that the ICAO flight plan code for Blocks 10 (Equipment and Capabilities) and 18 (Other Information) may be included in a table. For example, “RNP APCH – Block 10 may include “B” for LPV (APV with SBAS)”, and “G” for GNSS when Block 18 includes NAV/ SBAS, and “R” for PBN when Block 18 includes PBN/A1C2D2L1O2S1S2. For guidance, refer to ICAO Doc 4444, Procedures for Air Navigation Services, Air Traffic Management, Appendix 2.

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**4. AC 20-138D Capability Statement Examples**

4.1 Examples of PBN capability statements are also provided in AC 20-138D, Appendix 5, page A5-9, A5-2 (reference 3.2.2.a).

4.2 Samples of the 'Statement of Navigation Capability' provided below are from the CC150 Flight Manual Supplement. This FM Supplement was approved by Transport Canada as part of a Supplemental Type Certificate (STC) release for a design change to the CC150 (A310 model). This design change involved the installation of the CMC 9000 Flight Management System, the Triple Honeywell LaserRef IV Inertial Reference System, and the FANS-1/A+ System. This FM Supplement includes the following chapters and extracts:

a. CC150 Sample: Chapter 1 – Statements of Navigation Capability

<b>CHAPTER 1 - GENERAL</b> (contd.) <b>STATEMENTS OF NAVIGATION CAPABILITY</b> (contd.)	
<b>RNP 1</b>	
This FMS installation has been found to comply with the requirements of AC 20-138B and is eligible for operational approvals consistent with ICAO Performance Based Navigation (PBN) Manual RNP 1, including RF legs under the following minimum operating configuration:	
Single FMS in GPS, DME/DME or IRS (time limited as below) Navigation Mode Coupled to AP and/or FD. VOR/DME mode deselected.	
FMS in IRS Navigation Mode following a GPS or DME/DME mode failure time limit	0.5 hours maximum after FMS is placed in inertial navigation mode.

b. CC150 Sample: Chapter 2 – Limitations:

<b>CHAPTER 2 - LIMITATIONS</b> (contd.)
<b>IFR APPROACH LIMITATIONS</b>
1. ILS, LOC, LOC-BC, LDA, SDF, MLS and RNP AR approaches using the FMS/GNSS are prohibited.
2. FMS based instrument approaches must be conducted in the FMS Approach mode with the remote FMS APP annunciator LIT.
3. All instrument approaches using the GPS must be coupled to the flight director and autopilot or hand-flown using FD guidance.
4. Autopilot must not be coupled to PROFILE mode below 265 feet AGL.
5. GPS can only be used for approach guidance when navigation information is referenced to the WGS-84 reference system, and where the Aeronautical Information Publication (including electronic data and aeronautical charts) conform to WGS-84 or equivalent.



## **Navigation Databases (NavDB)**

### **1. General**

- 1.1 This annex provides advisory material for establishing the appropriate NavDB support arrangements.

### **2. Rationale and Guidance**

- 2.1 The Operational Airworthiness Authority (OAA) identifies the following avionics database requirements in the RCAF Flight Operations Manual (reference 3.2.2.1), Chapter 2, paragraph 2.3.6.2, titled *RNAV (GNSS) Operation Approval Requirements*:

- ‘2. **Database Requirement.** The avionics database must be current. The RNAV system must include a manufacturer supplied electronic database that can be updated, normally on 28- or 56- day cycles. The updating service is usually purchased under subscription from the avionics manufacturers or database suppliers.
- a. As database errors do occur, crews must verify that the retrieved data is correct. Prior to using the database for primary navigation, crews must verify the integrity of their database in accordance with the procedures outlined in GPH 204A. Additional verification should be accomplished by comparing waypoint co-ordinates found in the navigation database with a WGS-84 based chart. Crews can also check bearings and distances between waypoints found in the FMS against enroute charts. Any discrepancies shall be reported to the avionics database supplier.

### **NOTES**

1. *Not all nations use a reference datum of WGS-84 when determining the coordinates for navigation waypoints (this includes RNAV waypoints and NAVAIDS). While many host nation products (including those produced by Jeppesen) may display coordinates utilizing a variety of reference datums, all US DoD navigation products (and most RAF and RAAF products) are printed with WGS-84 coordinates.*
2. *All approaches must be retrieved from the avionics database. While it is acceptable to use pilot-generated waypoints en-route, it is not permitted for approach procedures as any database or waypoint coordinate errors could have serious consequences.*
- 2.2 The general operating procedures section in the PBN Manual (ICAO Doc 9613 Ed 4, section 3.3.4.2) prohibits civil aircraft from manually entering, or creating new waypoints by manual entry, of latitude and longitude or rho/theta values for RNAV 1, RNAV 2, RNP 1 and RNP 2. The creation of new waypoints by manual entry into the RNAV system by the flight crew would invalidate the route and is not permitted.
- 2.3 The Technical Airworthiness Authority (TAA) identifies the following NavDB database requirements in the ADSM, section 3.3.5, para 31 (regulatory reference 3.2.1.b), which states:
- ‘As part of the Technical Airworthiness Clearance (TAC) process, it will be required to demonstrate that an aeronautical data support arrangement meets the objectives of DO-200B, that the NavDB is compatible with the equipment, and that it is suitable for the intended use. In addition, the TAC will require the Type Certificate Holder organization to have a quality procedure that ensures DO-200B requirements will continue to be met once the NavDB is in service.’

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2.4 During the PBN Design Certification Process, the NavDB requirements will be addressed as part of the 'Instructions for Continued Airworthiness' certification requirement. The applicant will be required to provide a NavDB Support Plan that addresses the following requirements:

- a. How the NavDB is, or will be, produced and delivered to the aircraft, including the responsibilities of each organization in the data chain of the NavDB, beginning with authoritative data sources (usually a State), and finishing with the organization(s) that install the NavDB on the aircraft.

**NOTES**

1. *For additional information about the types and sources of NavDBs acceptable to the TAA, see the ADSM, Part 3, Chapter 3, Section 3.3.5, paras 29 – 33 (regulatory references 3.2.1.b). This reference also identifies the TAA-accepted NavDB design standards.*
2. *If the NavDB data source does not have a Civil Airworthiness Authority (CAA)/ Military Airworthiness Authority (MAA) recognition for providing aeronautical data, the certification activities will have to include the recognition of the data source provider. The recognition or acceptability of the data source provider will be performed by DTAES 4 and 6 staff.*

- b. Identify the navigation data process, i.e., receive, assemble, etc., that will need to be performed by DND upon reception of the NavDB, and the support provided for the performance of these processes by the vendor or acceptable support organization.
- c. Identify any validation activities that are passed to the end user, and any data elements that are not covered by CAA/MAA recognition (referred to as 'tailored data').
- d. Address the following in the NavDB in-service support arrangements and procedures:
  - (1) Identification of the DND/CAF organization(s) responsible for managing the NavDB;
  - (2) Documented procedures for validating the navigation databases and installing new/updated databases into aircraft to maintain currency. This includes procedures for any navigation data processes performed by DND;
  - (3) Maintenance of the NavDB quality requirements to ensure the availability of an accurate and up-to-date navigation database;
  - (4) Monitoring and control of the release and authorized use of the data;
  - (5) Monitoring and control of any in-service NavDB updates and changes, including changes to aeronautical data chain management processes;
  - (6) Monitoring and control of any NavDB update or amendment processes performed by DND or DND support organizations;
  - (7) Verification and reporting of errors to the navigation database supplier; and
  - (8) Control of the NavDB part numbers/version numbers and the associated aeronautical data support equipment.

2.5 Additional guidance material for developing the NavDB support plan is available in FAA Advisory Circular (AC) 20-153 (reference 3.2.2.m). This AC provides guidance material for showing compliance with FAA's airworthiness requirements for equipment with an installed aeronautical database. The FAA's target audience for this AC is the aeronautical data suppliers (e.g., data providers, application integrators, etc.), aircraft manufacturers, avionics manufacturers, and operators / end-users.

## Operational Airworthiness Clearance Considerations for PBN (Step 8)

### 1. General

- 1.1 This annex provides guidance on meeting the PBN-related operational approval requirements identified in the ICAO PBN Manual and the FAA AC 20-138D.

### 2. Rationale and Guidance

- 2.1 The operational approval of a PBN capability on DND/CAF aircraft will be addressed by the OAA during the Operational Airworthiness Clearance (OAC) of a new aircraft fleet, or the OAC issued for a PBN design change to an in-service fleet. This annex identifies the operational approval requirements defined in ICAO PBN Manual (reference 3.2.2.c) and the FAA AC 20-138D (reference 3.2.2.a).
- 2.2 The ICAO PBN Manual (reference 3.2.2.c), Vol 1, Attachment C, "Operational Approval", identifies the operational requirements that must be addressed during the approval of a PBN capability. PBN operational approval is the responsibility of the regulatory authority of the State of the Operator.
- 2.3 As described in the PBN Manual, para 3.2, the PBN operational approval assessment must take into account the following:
- a. aircraft eligibility and airworthiness compliance (addressed by TAC process);
  - b. operating procedures for the navigation systems used;
  - c. flight crew and dispatch personnel initial training;
  - d. control of navigation database procedures. The fleet Weapons System Managers (WSMs) and their operational units should have documented procedures for the management of navigation databases. These procedures will define the data validation procedures for navigation databases and the installation of new databases into aircraft so that they remain current.
- 2.3.1 **Navigation System – Operating Procedures.** The ICAO PBN Manual, para 3.4, identifies the following requirements for operating procedures:
- a. must be developed to cover both normal and non-normal (contingency) procedures for the systems used in the PBN operation;
  - b. must be adequately documented in the Operating Manuals and checklists;
  - c. must address:
    - (1) preflight planning requirements, including the MEL and, where appropriate, RNP/RAIM prediction;
    - (2) actions to be taken prior to commencing the PBN operation;
    - (3) actions to be taken during the PBN operation; and
    - (4) actions to be taken in the event of a contingency, including the reporting of significant incidents.

#### NOTE

*Navigation system operating procedures receive technical approval as part of the sign-off of certification requirement 1581. Providing the OAA does not make changes, the TA approval is sufficient.*

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- 2.3.2 **Flight Crew Training.** The flight crew and dispatch training program for the PBN operation must cover all the tasks associated with the operation, and provide sufficient background to ensure a comprehensive understanding of all aspects of the operation. The operator must have adequate records of course completion for flight crew, flight dispatchers and maintenance personnel.
- 2.4 **Additional OAC Considerations.** The following are examples of information arising from the PBN design assessment and approval activities that may need to be considered for inclusion in the flight manual, or other operational support document, during the approval of an OAC:
- a. Situations when a manual scale setting is necessary, as shown in the following example from the CC150 flight manual:  
  
“Crews should be aware that each pilot must manually select 1 NM scaling when flying a terminal procedure that begins or ends more than 30 NM from the destination or departure airport.”
  - b. Operational Mitigations for AFM Limitations, for example:  
  
“RNAV 10 operations with one serviceable GPS are prohibited because the maximum time the INS can continue to support RNAV 10 operations without a GPS input is not known, and has been limited to a conservative period of 2 hours. RNAV operations can be safely undertaken with one serviceable GPS and one INS when the performance of the installed INS is shown to meet the requirements of the navigation specification. Data collected during operational flights in accordance with FAA AC 90-105A (or later revision) can be used to support dispatch with one GPS.”
- 2.5 **Diplomatic Clearance Requests.** The following is an example of a PBN assessment statement that was developed for distribution to foreign governments and state agencies to support a diplomatic overflight/landing clearance request for the CC150:
- “The Minister of National Defence has determined that the CC150 airplane has the navigation accuracy, integrity and continuity defined by the ICAO PBN Manual for RNP 4, RNP 2, RNP 1 and RNP APCH using the GNSS satellite constellation. The determination was made by persons in the DND airworthiness organization that are qualified and trained to standards similar to those met by persons performing a comparable role for Canada’s Civil Airworthiness Authority, and using the criteria published by the FAA in AC 20-138D, Change 2. The dual navigation computers and GNSS receivers have received design approvals from both the FAA and EASA.”

## **Additional Considerations for PBN Design Changes to Legacy Military Aircraft**

### **1. General**

- 1.1 This annex provides guidance on certifying PBN design changes to legacy military avionics systems.

### **2. Rationale and Guidance**

- 2.1 Military aircraft are often developed using military avionics design standards that may differ from the civil aviation standards assumed by the authors of AC 20-138 (reference 3.2.2.a). In particular, this is the case for legacy military navigation and flight management systems.

- 2.2 The addition of a PBN capability to legacy military avionics systems may result in certification issues that have not been anticipated in AC-20-138D. The following are examples of issues that may be encountered:

- a. **Certification Basis.** The certification basis examples shown in Annex B use the civil certification requirements. For legacy military aircraft that were designed to military standards and not civil certification standards, there is the option to develop the PBN certification basis using military airworthiness codes, such as U.S. DoD Mil-Hdbk-516, or European Military Airworthiness Certification Criteria (EMACC), as described in Part 1, Chapter 2 of the ADSM, (regulatory reference 3.2.1.b).
- b. **Non-TSO Systems.** Most of the criteria used in AC 20-138D assume the use of GPS receivers and Flight Management Systems (FMS) that have been certified to FAA Technical Standard Orders (TSOs), or equivalent. A TSO is a minimum performance standard published by the FAA for specified materials, parts, processes, and appliances used on civil aircraft. The equipment tables in Part 3, Chapter 3 of regulatory reference 3.2.1.b provide a listing of these TSOs that apply to GPS receivers, FMS and other navigation systems. The absence of a TSO for the navigation and flight managements systems on DND/CAF aircraft may be problematic. Examples of such potential problems include the following:
  - (1) Lack of the required equipment redundancy, e.g., dual GNSS receivers;
  - (2) Military avionics software not developed to civil software or complex electronic hardware development standards, such as DO-178 or DO-254 listed in Part 2, Chapter 4 of the ADSM (regulatory reference 3.2.1.b);
  - (3) FMS functions embedded in aircraft mission computers that provide an FMS-like capability, but may not include all of the functionality required for PBN;
  - (4) Flight instrument display systems that do not provide the resolution or information display capability specified in AC 20-138D; and
  - (5) Avionics systems that do not have the data validation and verification processes required by the PBN criteria to maintain the NavDB Integrity throughout all phases of the data handling process. This may be an issue where the NavDB consists of

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Digital Aeronautical Flight Information File (DAFIF) formatted data, in full or part, from the US National Geospatial-Intelligence Agency.

- c. **Additional Requirements for Non-TSO Systems.** Avionics equipment that has not been certified to the FAA TSOs can be replaced with Military Standard Order (MSO) certified equipment. For equipment that has not been certified to either a TSO or a MSO, the following will apply:
- (1) AC 20-138D makes provisions for the use of non-TSO systems. The process described in AC 20-138D Change 2, Section 7-1.b (1) may be used to achieve airworthiness approval for PBN capabilities when the navigation equipment does not have a TSO/MSO-approval. The design must be evaluated to show compliance with the requirements of RTCA DO-236C, Change 1 (reference 3.2.2.f). In addition, the TAA requires that the design must also be assessed against the requirements of RTCA DO-283B (reference 3.2.2.e), as modified by TSO C115d (reference 3.2.2.g), and any deficiencies are documented.
  - (2) When the design incorporates non-TSO/MSO sensors, or a non-TSO/MSO navigation computer (that provides flight management functions), the AC-20-138D criteria may need to be augmented or replaced with criteria from one or more of the following three documents: RTCA DO-236, RTCA DO-283 and RTCA DO-229 (reference 3.2.2.m). Note that the RTCA documents do not refer to particular navigation specifications, and must therefore be addressed in their entirety.
  - (3) In some instances, the lack of TSO/MSO systems may only be addressed by one of the following measures:
    - i. Replacing the avionics system with TSO/MSO compliant systems;
    - ii. Reducing the approved PBN capability to align with the existing avionics system capabilities; or
    - iii. Employing operational procedures to compensate for the missing avionics system capabilities.